CLAIMS

1. A method of actuating, comprising:

filling at least a portion of a tube with a liquid containing electrolytes, the tube having an inner surface that is electrically chargeable when in contact with the liquid;

positioning an object in fluid communication with the liquid in the tube; and

applying an electrical field along a lengthwise axis across the tube at said portion for producing a pressure in the liquid;

wherein the pressure in the liquid exerts a force on the object so as to actuate the object.

2. The method of claim 1, wherein the inner surface is electrically chargeable due to electrochemical phenomena.

3. The method of claim 1 or claim 2, wherein the tube is selected from the group comprising: capillary tube and micro-capillary tube.

4. The method of any one of claims 1 to 3, wherein the tube has an open end and the object is in fluid communication with the liquid in the tube through the open end.

5. The method of any one of claims 1 to 4, further including an additional plurality of tubes each at least partially filled with a liquid containing electrolytes in fluid communication with the object.

6. The method of claim 5, wherein the plurality of tubes are formed in a porous material.

7. The method of claim 6, wherein the porous material is made from at least one material selected from the group consisting of: silica, and ceramics.

8. The method of claim 7, wherein the porous material has at least one material property selected from the group consisting of: electrically non-conductive, porous structure, micro capillaries, small particles, and hydrophilic.

9. The method of any one of claims 1 to 8, wherein the electric field is generated from a power supply selected from the group consisting of: AC and DC.

10. The method of claim 9, wherein the DC power supply is linked to an on-off frequency controller.

11. The method of any one of claims 1 to 10, wherein the pressure in the liquid is caused by electroosmotic flow.

12. The method of claim 6, wherein a higher force on the object is generated by adopting techniques selected from the group comprising: using porous material with small pore sizes and using porous material with large cross-sectional areas.

13. The method of claim 1, wherein a higher force on the object is attained by using a lower concentration of the liquid containing electrolytes.

14. The method of claim 1, wherein a higher force on the object is attained by generating a stronger electric field.

15. The method as claimed in any one of claims 1 to 13 when as used in an actuator.

16. An actuator comprising:

a tube with an inner surface and at least partially filled with a liquid containing an electrolyte, the inner surface being electrically chargeable when in contact with the liquid;

an electric field generator for generating a field along a lengthwise axis of the tube to induce a pressure in the liquid;

an object in fluid communication with the liquid such that the pressure in the liquid exerts a force on the object;

and wherein the force on the object is able to actuate the object.

17. The actuator of claim 16, wherein the inner surface is electrically chargeable due to electrochemical phenomena.

18. The actuator of claim 16 or claim 17, wherein the tube is selected from the group consisting of: capillary tube and micro-capillary tube

19. The actuator of claim 16 or claim 17, wherein the tube has an open end and the object is in fluid communication with the liquid in the tube through the open end.

20. The actuator of claim 19, further including an additional plurality of tubes each at least partially filled with a liquid containing electrolytes in fluid communication with the object.

21. The actuator of claim 20, wherein the plurality of tubes are formed in a porous material.

22. The actuator of claim 21, wherein the porous material is of at least one material selected from the group consisting of: silica, and ceramics.

23. The actuator of claim 21, wherein the porous material has at least one material property selected from the group consisting of: electrically non-conductive, porous structure, micro capillaries, small particles, and hydrophilic

24. The actuator of any one of claims 16 to 23, wherein the electric field generator generates power supplies selected from the group consisting of: AC and DC.

25. The actuator of claim 24, wherein the DC power supply is linked to an on-off frequency controller.

26. The actuator of any one of claims 16 to 25, wherein the pressure in the liquid is caused by electroosmotic flow.

27. The actuator of claim 21, wherein a higher force on the object is generated by adopting techniques selected from the group consisting of: using porous material with small pore sizes, and using porous material with large cross-sectional areas.

28. The actuator of claim 16, wherein a higher force on the object is attained by using a lower concentration of the liquid containing electrolytes.

29. The actuator of claim 16, wherein a higher force on the object is attained by generating a stronger electric field.

30. The actuator of any one of claims 16 to 29, further comprising a housing defining a chamber containing the tube, and a cylinder in fluid communication with the chamber, wherein the tube is in the cylinder and the object is a piston slideably mounted in the cylinder.

31. The actuator of claim 30, wherein the piston is biased to resist a force exerted thereon from the tube.

32. The actuator of claim 31, further comprising a displacement amplifier operatively connected to the piston.

33. The actuator of claim 30, wherein the piston has silicone seals.

34. The actuator of claim any one of claims 21 to 23, or any one of claims 24 to 27 when appended to claim 21, further comprising a compensating piston to prevent a drop of pressure in the porous material.

35. The actuator of claim 30, further comprising a vent in the housing for allowing the exchange of air within the chamber.

AMENDED CLAIMS

[Received by the International Bureau on 31 March 2005 (31.03.05):
original claims 4 and 19 have been cancelled. Original claims 1-3, 5-18, 20-35 have been replaced by amended claims 1-33 (4 pages)]

1. A method of actuating, comprising:

filling at least a portion of a tube with a liquid containing electrolytes, the tube having an open end and an inner surface that is electrically chargeable when in contact with the liquid;

positioning an object in fluid communication with the liquid in the tube through the open end; and

applying an electrical field along a lengthwise axis across the tube at said portion for producing a pressure in the liquid;

wherein the pressure in the liquid exerts a force on the object so as to actuate the object.

2. The method of claim 1, wherein the inner surface is electrically chargeable due to electrochemical phenomena.

3. The method of claim 1 or claim 2, wherein the tube is selected from the group comprising: capillary tube and micro-capillary tube.

4. The method of any one of claims 1 to 3, further including an additional plurality of tubes each at least partially filled with a liquid containing electrolytes in fluid communication with the object.

5. The method of claim 4, wherein the plurality of tubes are formed in a porous material.

6. The method of claim 5, wherein the porous material is made from at least one material selected from the group consisting of: silica, and ceramics.

7. The method of claim 6, wherein the porous material has at least one material property selected from the group consisting of: electrically non-conductive, porous structure, micro capillaries, small particles, and hydrophilic.

8. The method of any one of claims 1 to 7, wherein the electric field is generated from a power supply selected from the group consisting of: AC and DC.

9. The method of claim 8, wherein the DC power supply is linked to an on-off frequency controller.

10. The method of any one of claims 1 to 9, wherein the pressure in the liquid is caused by electroosmotic flow.

11. The method of claim 5, wherein a higher force on the object is generated by adopting techniques selected from the group comprising: using porous material with small pore sizes and using porous material with large cross-sectional areas.

12. The method of claim 1, wherein a higher force on the object is attained by using a lower concentration of the liquid containing electrolytes.

13. The method of claim 1, wherein a higher force on the object is attained by generating a stronger electric field.

14. The method as claimed in any one of claims 1 to 12 when as used in an actuator.

15. An actuator comprising:

a tube with an open end and an inner surface and at least partially filled with a liquid containing an electrolyte, the inner surface being electrically chargeable when in contact with the liquid;

an electric field generator for generating a field along a lengthwise axis of the tube to induce a pressure in the liquid;

an object in fluid communication with the liquid in the tube through the open end such that the pressure in the liquid exerts a force on the object;

and wherein the force on the object is able to actuate the object.

16. The actuator of claim 15, wherein the inner surface is electrically chargeable due to electrochemical phenomena.

17. The actuator of claim 15 or claim 16, wherein the tube is selected from the group consisting of: capillary tube and micro-capillary tube

18. The actuator of any one of claims 15 to 17, further including an additional plurality of tubes each at least partially filled with a liquid containing electrolytes in fluid communication with the object.

19. The actuator of claim 18, wherein the plurality of tubes are formed in a porous material.

20. The actuator of claim 19, wherein the porous material is of at least one material selected from the group consisting of: silica, and ceramics.

21. The actuator of claim 19, wherein the porous material has at least one material property selected from the group consisting of: electrically non-conductive, porous structure, micro capillaries, small particles, and hydrophilic

22. The actuator of any one of claims 15 to 21, wherein the electric field generator generates power supplies selected from the group consisting of: AC and DC.

23. The actuator of claim 22, wherein the DC power supply is linked to an on-off frequency controller.

24. The actuator of any one of claims 15 to 23, wherein the pressure in the liquid is caused by electroosmotic flow.

25. The actuator of claim 19, wherein a higher force on the object is generated by adopting techniques selected from the group consisting of: using porous material with small pore sizes, and using porous material with large cross-sectional areas.

26. The actuator of claim 15, wherein a higher force on the object is attained by using a lower concentration of the liquid containing electrolytes.

27. The actuator of claim 15, wherein a higher force on the object is attained by generating a stronger electric field.

28. The actuator of any one of claims 15 to 27, further comprising a housing defining a chamber containing the tube, and a cylinder in fluid communication with the chamber, wherein the tube is in the cylinder and the object is a piston slideably mounted in the cylinder.

29. The actuator of claim 28, wherein the piston is biased to resist a force exerted thereon from the tube.

30. The actuator of claim 29, further comprising a displacement amplifier operatively connected to the piston.

31. The actuator of claim 28, wherein the piston has silicone seals.

32. The actuator of claim any one of claims 19 to 21, or any one of claims 22 to 25 when appended to claim 19, further comprising a compensating piston to prevent a drop of pressure in the porous material.

33. The actuator of claim 28, further comprising a vent in the housing for allowing the exchange of air within the chamber.